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Thesis for the degree
Master of Science.

A STUDY OF THE THORACIC SCLERITES OF LEPIDOPTERA

By George A. Root, B.S.

Massachusetts Agricultural College,
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Introduction.

The purpose of this paper is to homologize the sclerites of the Lepidoptera and incidentally attempt to determine to what extent these structures may be taken as indicative of the place which the various families hold in the phylogenetic scale of classification. Much literature has been written about the thorax of a single species or family, but little or none about the group as a whole and especially with reference to the possible relationship of the families as deduced from thoracic characters.

Schultz 1914, deals with the pronotum and patagia of the Lepidoptera and attempts to show the phylogenetic relationship among the families. The writer of this paper has taken the mesothorax mainly in determining the relationship because of its large size and importance. Slight variations frequently occur in the same species which make it oftentimes very difficult to determine the true nature of the part involved.

* A contribution from the Entomological Laboratory of the Massachusetts Agricultural College, Amherst, Mass., representing the greater part of the writer's work for the degree of Master of Science.

The Lepidopterous thorax is covered with a thick vestiture of hair and scales which must be removed before a study can be made. This is easily accomplished by the use of a stiff brush after having boiled the thorax in caustic potash for a short time. This treatment also greatly aids in separating the sclerites and making the sutures more distinct.

Seven families of moths, representative of the lowest to the highest, have been selected as well as the four families of butterflies. Other intermediate families have been studied but owing to the similarity of parts in question, it was deemed unnecessary to discuss them in this paper. The writer has endeavored in the majority of cases to select species well known from their economic standpoint or widespread distribution.

Thanks are due to Dr. G. C. Crampton for the loan of material and for the many helpful suggestions offered in the course of the preparation of this paper and to Dr. M. T. Fernald for his interest shown at all times.

There is still considerable divergence of opinion as to the phylogenetic relationship of many Lepidopterous families, especially those of the higher Heterocera, and after a careful study of the classifications of several systematists, that of Comstock has been selected as perhaps being the most useful.

The following is the list of the families arranged in phylogenetic order and studied in the same manner. The list begins with the lowest family and proceeds to the highest.

1. HETEROCERA.

Hepialidae.

Phassus schamyli- Figs.1,2,3,8.

Sesiidae.

Bembecia marginata- Figs. 11,12.

Geometridae.

Metrocampa praegrandraria- Fig. 14.

Lymantriidae.

Porthetria dispar- Fig. 15.

Arctiidae.

Arctia sp. - Figs. 13, 16.

Sphingidae.

Sphinx sp. - Figs. 4, 6, 17.

Saturniidae.

Samia cecropia- Figs. 5, 18.

11. RHOPALOCERA.

Hesperiidae.

Epargyreus tityrus- Fig. 22.

Papilionidae.

Papilio glaucus- Figs. 19, 20.

Pieridae.

Pontia rapae- Figs. 9, 23, 24.

Nymphalidae.

Anosia plexippus- Figs. 7, 10, 21, 25.
Argynnis cybele- Figs. 26.

1. The Thorax of Phassus schamyli and the Hepialidae.

Before proceeding with a comparative study of the thoraces of the several Lepidopterous families, a comparison of a generalized Lepidoterous thorax with those of the lower orders is essential. Phassus schamyli is a native of the Caucasian Mountains of Russia and has been selected because its greater size makes it one of the best of the more primitive Lepidoptera for study. The very primitive generalized shape of the Hepialid thorax is noteworthy. It is seen to possess many of the sclerites of the lower orders while others are missing, probably having become indistinguishably fused with other sclerites. (See Figs. 1, 2, 3). It should be mentioned at this point that the terminology largely employed in the following thoracic descriptions is that used by Dr. G. C. Crampton, '08, '09, '14.

THE PROTHORAX. This segment is greatly reduced in size and complexity as compared with some of the lower forms such as the Roach and it is exceedingly difficult to homologize all of the parts, but certain of the sclerites are similar to those of Neuroptera such as Corydalis. (See Crampton '14.)

Pronotum.- This is one of the largest sclerites of the prothorax (Fig. 1). It may be divided into two parts, a posterior rather narrow plate, the scutellum, (Sl) and immediately in front and extending somewhat laterally, a broad plate part of which is semi-chitinous. From the position of this sclerite is seems quite probably that it is the scutum (Sc) part of which in higher Lepidoptera becomes modified into patagia. These patagia are lobe-like

leathery or membranous structures of the pronotum, well developed in higher Heterocera. Fig. 5 shows a dorsal view of a typical Lepidopterous pronotum as illustrated by the Saturniid form, Samia cecropia. The patagia (Pat) are well developed but membranous in this family and the chitinous portion of the scutum (Sc) is much reduced. These patagia are simply developments of the pronotum and are not homologues of wings nor tegulae (Tg) of the mesothorax with which they are frequently confused. Immediately anterior and united with the scutum is a narrow chitinous structure which shortly divides into two arms, each of which extends downward and around the upper portion of the pleuron and unites with the upper part of the episternum (Es). From its position anterior to the scutum, this structure in all probability corresponds to the prescutum of other segments. Posterior to and united with the scutum is the scutellum (Sl) which assumes in all the higher forms a characteristic triangular shape and extends posteriorly, nearly or quite meeting the prescutum of the mesothorax. According to Schultz 1914, a postscutellum is present in the prothorax, and the sclerite here designated as the scutellum (Sl) by the writer was there termed the "postscutellum." This is apparently incorrect for the postscutellum is always distinct and separated from the scutellum by a more or less membranous region. Furthermore, the postscutellum is absent in the prothorax of all the lower insects and it is therefore quite probable that there is no postscutellum in the pronotum of Lepidoptera.

Propleuron.- Returning to Fig. 1, the propleuron or lateral region of the prothorax is much compressed and consists of

several sclerites. In some of the lower orders the propleuron is much better developed and its parts quite easily determined. The large oval sclerite is undoubtedly the episternum (Es) and immediately posterior to it is a narrow folded region which appears to be the epimeron (Em). Anterior to and connected with the episternum (though in higher forms it is slightly separated from the latter) is a chitinous plate of the neck region known as the cervical sclerite (Cs). In the Odonata, Orthoptera and Coleoptera there are several of these which are quite prominent. The spiracle (Sp) of the mesothorax is situated just ventral to the scutum, and anterior to the katepisternum (Kes) of the mesothorax (Fig.2).

Sternum.- ~~This~~ This region of the prothorax, the greater part of which comprises the basisternite (Bs) is a small but well defined area. Its position, articulations and processes with slight modifications are similar to those of the mesothorax which is later discussed in this paper so further consideration on this point is unnecessary.

Coxa.- The prothoracic coxa (Cx) is somewhat cylindrical and unlike the meso- and metathoracic coxae which are broadly and immovably joined to the pleuron, it articulates with the lower portion of the pleuron by means of an upper narrow apical region. The membranous area occuring in all Lepidoptera at the articulation of coxa and trochanter, though in many families quite small and inconspicuous, is extensive in this form and occupies a large part of the lower portion of the coxa. Within this membranous area is a small chitinous plate.

THE MESOTHORAX. This is the largest and most highly developed

of all the three segments and is roughly triangular in shape (Fig.2). The wings in all lateral views have been represented as pushed up and back and cut off close to the base.

Mesonotum.- This part of the mesothorax comprises the entire dorsal region and is composed of two distinct plates, an anterior one here referred to as the scuto-scutellum (Scsl) which bears the wing along its lateral margin and a posterior plate, the postscutellum (Psl) which is not connected with the wing, but is united with the epimeron (Em) by a postalar bridge (Poa) extending behind the wing. Fig. 4 represents the dorsal aspect of a Sphingid mesonotum and though drawn primarily to show the wing articulation which will be discussed later, clearly shows the relation of the parts of a typical Heterocerous mesonotum.

The anterior plate of the mesonotum, the scuto-scutellum (Scsl) is by far the largest plate occupying the dorsal portion. It is more or less divided into three regions, the first being the prescutum (Psc), the second the scutum (Sc) and the third the scutellum (Sl). The lines of demarcation between these three sclerites are internal folds or "implexes" whose approximated lips forms the external suture. The scuto-scutellum is therefore one chitinous piece which has become secondarily marked off into the three regions mentioned above.

The prescutum (Psc, Figs. 6, 8) is a small anterior region usually vertical being bent downward and ordinarily concealed from view. In the majority of families it is only partially separated from the scutum (Sc) laterally by membrane (Fig.8). However in some of the intermediate forms between the lowest and highest, the line of demarcation is quite distinct, as for instance in the

Sphingidae (Fig.6). The lower portion of the prescutum projects inward to form an internal process called the anterior phragma (Aphg, Figs. 6,8). In many of the lower orders the prescutal region is quite large and distinctly marked off. It likewise extends posteriorly in such cases and nearly meets the scutellum, thereby causing the scutum to become greatly reduced in size. The prescutum of the Neuroptera illustrates this condition. (See Crampton 1914.).

The scutum (Sc) forms the greater part of the scuto-scutellum (Scsl). It is laterally convex and broadest behind the middle. At the anterior end of the scutum is a special projection which bears a lobe-like structure usually covered with long hairs called the tegula (Tg). These tegulae are prominent in all Lepidoptera and cover a portion of the fore wings at their bases as well as a portion of the scutum. Part of the tegula (Tg) is cut off in Fig. 2, as is the case in all figures where lateral views of thoraces are shown. Where the tegula proper is missing, the point of attachment has likewise been designated the "tegula" (Tg).

The scutellum is a convex triangular sclerite about one-fourth the size of the scutum. Its posterior region assumes a vertical position well marked off in this family. This narrow vertical strip has been termed the postergite (Pt) and it is undoubtedly homologous with the region designated as the postergite of some of the lower orders. (See Crampton 1914.). This region is not so prominent in all the families as it is in this primitive one, there being but indications of it in a few others.

The postscutellum (Psl) is a transverse plate posterior

to the scutellum (Sl) and separated from it by a narrow membfane infolded beneath the postergal region. The postscutellum is connected laterally with the epimeron (Em) of the pleural region by a postalar bridge (Poa) as previously stated. At very nearly this point of connection, a portion of this postalar bridge projects forward, meeting or almost meeting the posterior extremity of the sclerite termed the subalare (Sa) situated immediately below the wing. The lower internal portion of the postscutellum is termed the posterior phragma (Pphg). It is generally well developed in insects with wings fitted for long sustained flight.

Wing Articulation.- In discussing the dorsal articulation of the wing, the mesonotum of a Sphingid form was selected because of its large size and since it is typical of the wing articulation of Lepidoptera in general (Fig. 4).

On either side of the scutum (Sc) immediately above the wing is a well developed suranal sclerite (Sur) which bears a pointed process known as the anterior notal wing process (Anp) with which the wing sclerite, the notopterale (Npt) articulates. A vertical extension of the notopterale dips beneath the wing membrane and rests and turns upon the wing process (Wp) of the pleuron. (See Figs. 2, 3). Posterior to the suranal pterale is another slight projection of the scutum to which the notopterale is connected, oftentimes but slightly.

The scutellum (Sl) is prolonged laterally into a process called the adanal pterale (Apt) whose distal extremity passes under the wing and known as the posterior notal wing process (Pnp). This

process acting partly as a wing support connects with the basanal pterale (San) another wing sclerite so named because of its position at the base of the anal veins. The connection of the basanal pterale with the posterior notal wing process (Pnp) occurs slightly beneath the wing membrane and is not shown in Fig. 4. The medipterale (m) lies approximately between the notopterale and the basanal pterale.

Between the lateral projections of the scutellum (Sl) and the postscutellum (Psl) respectively, there arises a membranous alar ligament generally known as the axillary cord (Axc) which extends to the anal angle of the wing. This cord is shown in all lateral views as well.

Mesopleuron.- This region comprises the lateral portion of the mesothorax and is composed of chitinous plates and membrane. A well established landmark for the separation of the principal sclerites of the mesopleuron is another internal folding or "implex" whose outward manifestation is the pleural suture (g) extends from the tip of the wing process to the articulation of the coxa (Cx). This suture (i) with the other forms a more or less oblique line and assumes varying degrees of curvature in the different families.

The mesopleuron is approximately divided vertically by the pleural suture into two parts, the anterior one known as the episternum (Es) and the posterior one known as the epimeron (Em). Both these parts enter into the formation of the wing process (Wp) immediately above which is one of the wing sclerites, the notopterale. The episternum as in the Neuroptera is divided

into an upper region or anepisternum (Aes) and a lower region or katepisternum (Kes). In the upper region of the episternum, there occurs at the base of the wing a partially detached plate (Pba) homologous with the posterior basalar plate of the lower insects, in some of which it is completely detached from the episternum. (See Crampton 1914.). The anterior basalar plate of the lower insects has apparently become fused with the upper portion of the episternum, so in the Lepidoptera there is really but one basalar plate (Pba). In the lower portion of the episternum a narrow posterior region (Acx) which is roughly homologous with the antecoxale of lower insects is clearly demarked. In other Lepidoptera it is greatly reduced and is partially fused with the lower part of the episternum, the suture between the two being partially preserved in most forms. Closely allied to this region is a small detached plate, the trochantin (Tn) articulating with the antecoxale and with the inner side of the coxa (Cx). This is a primitive feature and typical of many of the lower orders. In all other Lepidoptera, the trochantin is missing, obviously having become lost. The lower portion of the episternum is connected with the anterior part of the sternum by a precoxal bridge (Pcx) indistinguishably united with the episternum above and sternum below and not distinctly marked off as in some of the lower orders.

Immediately anterior to the episternum is a detached plate (Ip) homologous with the interpleurite of the Neuroptera and other lower insects. The epimeron (Em) is roughly "U"

shaped and is connected with the postscutellum (Psl) by the postalar bridge (Poa) extending behind the wing. Just above the epimeron and immediately beneath the wing is a roughly oval-shaped plate, the subalare (Sa). The epimeron is connected with the sternal region by a narrow postcoxal bridge (Poc) which unlike the condition found in lower insects and even in the Rhopalocera, is connected with the upper instead of with the lower region of the epimeron. This narrow chitinous strip, the postcoxal bridge, proceeds internally beneath the epimeron pursuing a downward course beneath the coxa and connecting with the furcasternite (Fs, Fig. 10). There is thus both a precoxal and a postcoxal bridge connecting the pleural and sternal regions.

Sternum.- This term is applied to the lower part of a thoracic segment and is often fused with the pleural region, there being no line of demarcation between them. In Phassus traces of a separation between the sternal and pleural regions are retained as shown in Fig. 2. The greater part of the sternum is made up of a shield-shape plate called the basisternite (Bs). This is partially separated from the katepisternum (Kes) of the pleural region by a narrow membranous area. Posterior to the basisternite is the furcasternite (Fs, Figs. 10,12) which extends backward between the coxae as a folded chitinous band. At its distal extremity it slightly expands on either side into slightly triangular shaped regions which project into the coxal region and articulate with the inner sides of the veracoxae (Vcx). Immediately posterior to the furcasternite is the inner extremity of the postcoxal bridge (Poc). Though Fig. 10 represents the

sternum and shows the sternal processes of a typical Rhopalocerous form, so closely does the typical Heterocerous form approximate it, that Fig. 10 will suffice for both groups. A median ventral fold, the mid ventral "implex", manifesting itself externally as a suture divides the sternal sclerites into symmetrical halves in all forms of Lepidoptera.

Coxa.- This appendage (Fig.2) of the mesothorax is situated ventral to the epimeron (Em) and is divided into two parts by the meral suture (1). This suture not only partly divides the coxa oftentimes but does not exist in some lower forms, in which case the coxa is without division into two parts. As in the prothoracic coxa there is a large membranous area at the articulation of coxa and trochanter within which is embedded a small chitinous plate. The anterior portion is called the veracoxa (Vcx) and the posterior portion the meron (Me). These parts of the coxa are closely united with the lower portion of the pleuron and the consequent loss of mobility is compensated by the free movement of the trochanter.

THE METATHORAX. This segment is very similar to the mesothorax but is much narrower antero-posteriorly (Fig.3).

Metanotum.- This region is accordingly smaller and becomes much shortened in the higher forms. The scuto-scutellum (Scsl) bears the second pair of wings. A prescutum and an anterior phragma are absent. In the higher forms the scutellum (Sl) extends forward and in some cases divides the scutum (Sc) into two lateral halves. A narrow postergite (Pt) is present occupying the same region as in the mesothorax. The postscutellum (Psl) is fused laterally with epimeron and as in the preceding

segment bears a small vertical posterior phragma.

Metapleuron.- This region does not differ markedly from the mesopleuron. The upper part of the episternum as in the mesothorax bears one basalare (Pba) which differs however in the presence of a "U" shaped prologation. Just above the wing process (Wp) is the wing sclerite (Wpt) as in the mesothorax. A trochantin (Tn) is present occupying a similar position as in the mesopleuron. One marked difference however is the fusion of the basisternite (Bs) and the lower part of the episternum into one piece, there being no line of demarcation as in the case of the previous segment. The interpleurite of the mesothorax is missing in this segment as well as the tegula.

The posterior upper portion of the epimeron is fused with the chitinous portion of the first abdominal segment as is the posterior phragma of the postscutellum (Psl). A small membranous region occurs in the lower posterior portion of the epimeron. Above the epimeron and immediately behind the wing as in the mesothorax is the subalare (Sa). It is however cut off abruptly at the posterior end and is not connected with the small forward projection of the postalar bridge (Poa) as in the mesonotum (Fig.2). The metathoracic spiracle is situated just posterior to the postcoxal piece (Poc) of the mesothorax and anterior to metathoracic anepisternum (Aes).

Coxa.- This region assumes a slightly different shape from that of the mesothorax. A membranous area occurs in the upper part of the veracoxa (Vcx) and as in the coxae of the other segments a small chitinous plate is embedded in the

membranous region between the coxa and trochanter.

Modifications of the Heterocerous Thorax.

A comparative study of Lepidoterous thoraces shows that progressive modifications take place mainly in the elimination of sclerites by fusion, thereby resulting in a tendency towards simplicity. The mesopleuron and sternum will be dealt with mostly as mentioned in the opening of this paper, because the modifications in them are typical of the changes occuring in other segments and again because the modifications are more plainly seen and interpreted than elsewhere in the thorax.

The prescutum is not shown in the lateral views of the thorax with the exception of Fig. 2 but in each case the similarity either to the Hepialid or to the Sphingid type (Figs. 6,8) will be mentioned, as all moths approach one or the other in form. The families of the Heterocera will be taken up in phylogenetic order first and then those of the Rhopalocera, as the latter are conceded to be higher in the scale of classification.

Hepialidae- Phassus schamyli. See Figs. 1,2,3,8.

A discussion of this family has already been given in describing a typical generalized Lepidopterous thorax so further comment is unnecessary.

Sesiidae- Bembecia marginata, Raspberry Cane Borer.

The mesothorax as represented by Fig. 11 shows a rather aberrant type in that the scuto-scutellum is long and quite narrow and there is an extraordinary sculpturing and curved contour of the pleural sclerites.

The prescutum is much like that of the Hepialid type

(Fig.8). The tegula proper has been removed. There is a slight postergal region of the scutellum. The episternal region is quite different from that of the Hepialidae. There is a well-marked anepisternum (Aes) including a small triangular piece at its lower end next to the pleural suture (g . A large basalar plate (Pba) is present which together with the wing process is extended posteriorly to a marked degree. The wing also is situated well back upon the segment. In this family the antecoxale (Acx) becomes much reduced and is almost completely fused with the lower portion of the katepisternum, there being only a slight suture dividing the two. The trochanter is missing.

The epimeron (Em) is extremely distorted and the characteristic "U" shape is somewhat obliterated, owing to the large projection dorsally which closely approaches the subalare. This last mentioned sclerite is quite elongate and meets the extension of the postalar bridge (Poa). Posteriorly the epimeron merges into membrane, hence the chitinous portion is in contact only with approximately half of the meron (Me). The postcoxal piece (Poc) is plainly seen extending from the portion of the epimeron and proceeding internally.

The basisternite is marked off from the katepisternum posteriorly and from the interpleurite dorsally by sutures only. This plate, the interpleurite, is now an integral part of the mesopleuron having become fused however only with the katepisternum and not with the anepisternum. A suture only partially

divides the katepisternum (Kes) from the interpleurite (Ip).

The coxa is large and in the dorsal portion of the meron (Me) a narrow chitinous marginal strip is demarked and at the dorsal extremity of the veracoxa (Vcx) a small triangular plate is also marked off which is characteristic of all succeeding families. There is a small membranous area still visible between the coxa and trochanter but the small chitinous plate has become lost.

Fig. 12 is a latero-sternal view, drawn to show the general contour of the sternal region which resembles a shield in outline. The processes and articulations of the sternal region have previously been described under Phassus. At the upper end of the basisternite (Fig.12) are two narrow chitinous strips which unite in the median line and extend forward to the prothorax. These strips are the representatives of a triangular projection anterior to the basisternite shown in Fig. 14 and possibly homologous with the prebasisternite (Pbs) of lower insects. (See Crampton 1914.).

Geometridae- Metrocampa praegrandraria.

Owing to the similarity except for a few minor details, of this family to the preceding one, Fig. 14, showing a laterio-sternal view will suffice to show the relationship.

The pleuron is regular, the sculpturing and curves of the Sesiidae having disappeared. The anepisternum (Aes) assumes a more dorsal position in the episternal region than those of the two preceding families (Figs. 2,11). It is separated from the katepisternum (Kes) likewise by a narrow membranous strip and a

short suture. The antecoxale (Acx) is more prominent than that of the Sesiidae and extends well down along the posterior margin of the basisternite. The katepisternum is elongate and extends well up along the pleural suture, making the anepisternum correspondingly small. The interpleurite (Ip) occupies the same position as in Fig. 12 and is separated from the katepisternum and basisternite in similar manner. The sternal projection (Pbs) now assumes a definite shape and apparently is made up of a narrow ventral portion of the interpleurite and a dorsal portion of the basisternite. The epimeron is a well defined "U" shaped sclerite. The basalare (Pba) is relatively small and the wing process (Wp) is also short.

The dorsal portion of the coxa is overlapped by the antecoxale in this family as well as in the preceding one and those following with one exception. The characteristic membranous area between the coxa and trochanter and so prominent in the lower forms has now practically disappeared and is not present again to any extent in the higher forms except in the Lymantriidae.

Lymantriidae- Porthetria dispar, Gypsy Moth.

The mesothorax (Fig. 15) as a whole is long and rather narrow with a short but broad mesonotum. The prescutum is very similar to that of the Hepialidae (Fig. 8). The postergite (Pt) is quite wide in this form.

The episternum presents some new modifications. The anepisternum has not changed materially from that of the preced-

ing family. The basalare has assumed a roughly triangular shape with a small flap-like projection and is connected with the anepisternum at the anterior ventral apex. Marked off only partially by a suture which does not reach the pleural suture (g), thereby dividing it completely from the anepisternum as in the preceding forms, is the katepisternum. The line of demarcation between the katepisternum, the interpleurite and the basisternite is now complete for the first time in the form of a long unbroken suture. The antecoxale (Acx) has not varied in size nor position from that of the preceding family. The suture between the basisternite (Bs) and the interpleurite (Ip) is practically eliminated, though the separation between the two takes the form of a slight chitinous depression which is in line with the sternal projection (Pbs). The lower portion of the epimeron is traversed by two short sutures. The subalare is large, the greater portion being of a semi-chininous nature.

The coxa is exceedingly long and the area between the coxa and the trochanter is again manifestly membranous, a condition similar to that found in the more primitive moths of the Hepialidae and Sesiidae. The triangular piece in the upper part of the veracoxa is longer than usual and is not overlapped by the antecoxale as the membrane between the coxa and antecoxale is now plainly visible.

Arctiidae- Arctia sp. Fig. 16.

The mesonotum does not differ appreciably from that of the Gypsy Moth, in fact the whole segment is quite similar in general outline. The prescutum approaches that of the Hepialidae (Fig.8). The postergal region (Pt) is very narrow, there being

just an indication of such a sclerite.

The anepisternum is again completely separated from the katepisternum by a membranous strip and a suture as in Figs. 2, 11, 14. The basalare (Pba) is triangular with a flap-like portion partly overlapping the wing process (Wp). The katepisternum is broad and short and its separation from the interpleurite and basisternite is similar to that of the Lymantriidae (Fig. 15). The antecoxale (Acx) is extremely narrow and stops abruptly and does not continue ventrally along the basisternite as in previous forms.

The epimeron (Em) is distinctive because of a large detached triangular piece in the lower posterior region which is closely allied to the meron of the coxa. The subalare (Sa) as in the previous family is partly semi-chitinous. Its posterior part is elongated to meet the extension of the postalar bridge.

The anterior sternal projection is well developed and unusually broad. (See Fig. 13). The division between the interpleurite and the basisternite is also in the form of a depression in the chitin.

The coxa is long and narrow and the meron (Me) possesses a narrow chitinous strip at the dorsal end as does the meron of the Lymantriidae (Fig. 15). No membranous region is visible at the articulation of coxa and trochanter and the triangular piece at the dorsal end of the veracoxa (Vcx) is slightly rounded in shape. Fig.13 is a latero-sternal view of the Arctiid mesothorax.

Sphingidae- Sphinx sp.

The mesothorax of this family (Fig. 17) is more heavily

chitinized throughout than any other of the preceding forms. The mesonotum has been described and illustrated in Fig. 4. The prescutum (Psc, Fig. 6) is somewhat triangular and separated from the scutum by a narrow membrane. The tegula has been removed.

The anepisternum (Aes) is greatly developed and in turn the katepisternum (Kes) is relatively small. The suture marking off the anepisternum from the katepisternum does not extend to the pleural suture (g) hence this condition parallels that of the Lymantriidae (Fig. 15). The basalare (Pba) is large and heavily chitinized. The antecoxale is relatively wide but demarked from the katepisternum by only a short suture.

The epimeron (Em) is more angular than that of the Arctiidae and contains an oval piece adjacent to the pleural suture. Just ventral to the subalare (Sa) the epimeron gradually merges into membrane. The subalare is well chitinized and is prolonged posteriorly into an exceedingly narrow strip which extends upward to the projection of the postalar bridge. The axillary cord (Axc) has been cut to show this connection. The beginning of the postcoxal bridge (Poc) is seen in this figure at the upper posterior end of the epimeron and there is a slight indentation in the lower posterior region.

The line of demarcation between the interpleurite and the basisternite is even more indistinct than in the preceding form, though a suture is still present in the sternal projection and in line with this is a very slight depression of the chitin.

Saturniidae- Samia cecropia, Common Cecropia.

The mesothorax (Fig. 18) closely resembles in shape, size and form that of the Sphingidae. The anepisternum (Aes) is much reduced in size, owing to the encroachment dorsally of the katepisternum (Kes). The shape and position of the basalare (Pba) corresponds to that of the Sphingidae. The division between the anepisternum and katepisternum is only partial in the form of a short suture which does not extend to the pleural suture and being similar to the preceding family in this respect. The katepisternum is also separated from the basisternite and the interpleurite by a long unbroken suture as in the preceding family. The antecoxale is very narrow and practically divided from the katepisternum.

The epimeron is characteristically "U" shaped with long arms. There is an indication of a plate corresponding in position at least with the oval sclerite of the previous epimeron (Fig. 17). A small detached triangular plate occurs in the lower posterior region though it is less prominent than that of the Arctiidae (Fig. 16). The subalare (Sa) is large and differs somewhat in shape from that of the Sphingidae. The line of demarcation between the basisternite (Bs) and the interpleurite (Ip) is now practically eliminated even to the depression in the chitin, so the two now comprise one continuous plate. The coxa does not show any distinctive features.

2. The Thorax of Papilio glaucus and the Papilionidae

Papilio glaucus (Fig. 19) has been selected for the study of the Rhopalocerous thorax because of its large size. By comparing it with Phassus, the features common to the Lepidoptera as a whole may be shown as well as those special modifications

wherein the Rhopalocera differ from the lower forms.

THE PROTHORAX. This segment as in the moth is small, narrow and quite inconspicuous (Fig 19$_1$).

Pronotum.- This region of the prothorax is slightly convex and consists of a prescutum (Psc), a scutum (Sc) and a scutellum (Sl) as in the moth. The prescutum is small and is fused with the scutum which is heart-shaped and well chitinized. The scutellum is indistinguishably fused with the scutum and projects posteriorly approaching the mesothorax. On either side of the scutum and just posterior to the arms of the prescutum, indications of patagia are distinguishable as very slight elevations of the membrane. These structures in the other families of Rhopalocera with the exception of some forms of the Pieridae are well developed, extremely sac-like, of a leathery texture and slightly constricted at the base.

Propleuron.- This part of the segment is also quite similar to that of the moth. The episternum (Es) is large and oval in outline and the very narrow infolded sclerite is apparently the homologue of the epimeron (Em) of the moth prothorax. (See Fig. 1).

A cervical sclerite (Cs) is also present differing somewhat in shape from that in Fig. 1, and also in being disconnected with the episternum, though in close proximity to it. The mesothoracic spiracle (Sp) is situated posterior to the dorsal region of the epimeron (Em) and approximately anterior to the basalare (Pba) of the mesothorax.

Sternum.- This part of the butterfly prothorax

closely resembles that of the moth and presents no distinctive feature

Coxa.- This appendage is undivided. It is roughly cylindrical and is attached at its upper apical margin to the lower portion of the pleuron. It does not possess the large membranous area at its articulation with the trochanter as does Phassus (Fig. 1).

THE MESOTHORAX. This segment as in the case of all Heterocera is the largest of the three (Fig. 19).

Mesonotum.- In discussing the mesonotum of Papilio reference should be made to that of the Monarch butterfly as shown in Fig. 21. This figure was specifically drawn to be used in the discussion of the wing articulation, but incidentally shows the notum and relationship of parts so well that the study of the Rhopalocerous mesonotum will be made from this figure as well as from Fig. 19.

It is easily seen that the mesonotums of the butterfly and moth (Fig. 4) are quite similar in the relationship of the various parts. The scuto-scutellum (Scsl) is more convex and oval than that of the average moth, in fact the notum as a whole is narrower and longer. The prescutum (Psc) a very small portion which is shown at the anterior end of the scutum (Fig. 21) assumes as in the moths a vertical position and is fashioned much after that of the Hepialidae. Fig. 7 is a frontal view of the Monarch prescutum. The partial separation from the scutum is less marked than that of Phassus (Fig. 8) and the convexity of its lower portion is quite noticeable. The prescutum also bears a small anterior phragma. The Papilio prescutum is very similar to that of the Monarch.

The scutum is long and occupies the greater portion of the scuto-scutellum while the scutellum is small and varies slightly in shape in the several families. Sometimes it is long and narrow, and again it may be broad and short. There is a well mark postergal region (Pt). The tegulae (Tg) occupy the same position as those in the Heterocera with a slight lobe proceeding beneath the wing base as is the case with the Heterocera, though often small. The postscutellum (Psl) is separated from the postergite (Pt) by a wider membranous area than that occurring in moth forms. It is connected with the upper portion of the epimeron by a postalar bridge (Poa). A posterior phragma is present. The slight forward projection of the bridge still persists approaching the posterior end of the subalare (Sa, Fig. 19_2).

Wing Articulation.- The wing processes and articulations of a typical butterfly thorax are shown in Fig. 21. The Monarch or Milkweed butterfly has been selected because it is representative of the highest family of the Rhopalocera and furthermore because of its wide-spread distribution.

The suralar sclerites (Sur) are well defined areas on either side of the scutum and bear the anterior notal wing processes (Anp). The suralares differ in shape from those of the moth being more rectangular and less pointed. (See Fig. 4). Articulating with the anterior notal wing process (Anp) is the notopterale (Npt) which is also connected with another projection of the scutum posterior to the suralare (Sur). As in the moth, an extension of the notopterale proceeds beneath the wing membrane and reappears above the pleural wing process (Wp) upon which it pivots in the movements of flight

(Fig. 19). The adanal pterale (Apt) is a somewhat rounded piece apparently projecting from the scutum instead of from the scutellum as in the Heterocera. This sclerite also is more or less broken and its distal end, the posterior notal wing process (Pnp) is fused with a narrow downward projection of the basanal pterale (San) as in the moth. The medipterale (m) lies between the basanal pterale and the notopterale and is slightly connected with the latter.

The alar ligament or axillary cord (Axc) arises as in the moth between the lateral extension of the post-scutellum and scutellum and proceeds to the anal angle of the wing in typical manner.

Mesopleuron and Sternum.- The mesopleuron (Fig. 19) is divided into the episternum (Es) and epimeron (Em) by a strongly curved pleural suture (g). The epimeron is quite broad especially in the lower portion. The part approaching the wing process (Wp) is often infolded and quite narrow. Situated just above the wing process is the prolongation of the wing sclerite, the notopterale (Npt).

The subalare is situated posterior to the wing process and approaches in form that of the moth. Its posterior extremity does not quite meet the extension of the postalar bridge (Poa). The basalare (Pba) is divided into two parts in this form; the larger assumes a rectangular shape and the smaller is narrow and hook-shaped.

The episternal and sternal regions are now practically fused into one piece, the sutures between them evidently having been obliterated. It has seemed best in this instance

to designate the various regions, namely the basisternite, (Bs) the anepisternum (Aes) and the katepisternum (Kes) as though they were demarked as in the lower forms of Lepidoptera. The antecoxale (Acx) still persists as a narrow strip. The interpleurite is an integral part of the mesopleuron and is entirely marked off from the basisternite, a feature similar to that of the Sesiidae and Geometridae (Figs. 11, 14). It differs, however, from the Heterocera and Hesperiidae of the Rhopalocera in being contiguous with the anepisternum as well as with the katepisternum of the episternal region.

Fig. 20 is a latero-sternal view of the mesothorax of Papilio, showing more clearly the relation of parts. The sternal region has become proportionately larger and assumed a different shape from that exhibited by the Heterocera. The furcasternite (Fs) is narrow and folded upon itself resembling that of the Monarch (Fig. 10), and a description of which is given under the discussion of Phassus. Common to all butterflies though varying in size and form is a small triangular plate anterior to the basisternite and situated between the interpleurites. It is undoubtedly homologous with the sternal projection (Pbs) of the moth sternum.

Coxa.- This sclerite consists of the meron (Me) and veracoxa (Vcx) separated by the meral suture (l) as in the moth. A small membranous area occurs at the articulation of coxa and trochanter (not represented in Fig. 19, but similar to that as shown in Fig. 24.

THE METATHORAX. This segment (Fig. 19_3) is considera-

bly smaller than the mesothorax but quite similar in outline.

Metanotum.- This region is slightly compressed antero-posteriorly and comparatively small. The scutum (Sc) is divided into two parts, one occupying either side of the notum and bearing the wing processes. No tegulae are present. The scutellum (Sl) occupies the greater part of the middle portion of the notum and extends forward until it meets the posterior phragma of the mesothorax, thereby dividing the scutum into two parts. There is no prescutum nor anterior phragma. A narrow postergal region is present and the postscutellum bearing a small posterior phragma is fused with the first abdominal segment as in the moth. The postscutellum is also united with the upper part of the epimeron by a short postalar bridge, an extension of which does not exist to meet the subalare as in the mesothorax.

Metapleuron and Sternum.- The epimeron (Em) of this region is proportionately large and extends well down along the side of the meron (Me) where it proceeds beneath the coxa as the postcoxal bridge. The wing process (Wp) is curved backward to a marked degree, becoming almost horizontal. The notopterale is situated just above the wing process and posterior to this is the rather long and narrow subalare (Sa). The basalare (Fba) is roughly hook-shaped.

The episternal and sternal regions are indistinguishably fused and the single plate comprising both is more or less strap-shaped, differing thus from the roughly quadrate plate of the mesothorax. The precoxal bridge (Fcx) is well shown in this figure connecting the pleural and sternal regions.

A long narrow chitinous piece, the interpleurite (Ip) continu s along the anterior part of the episternal and sternal regions. The antecoxale is proportionately larger than that of the mesothorax and is demarked entirely from the lower portion of the episternal region. The metathoracic spiracle (Sp) is situated posterior to the epimeron (Em) of the mesothorax and ventral to the basalare (Pba) of the metathorax.

Coxa.- This appendage of the metathorax closely resembles that of the previous segment, though slightly different in shape. It is separated from the antecoxale (Acx) and the basisternite (Bs) by a wide membranous area. A small triangular piece still persists in the upper part of the veracoxa.

Modifications of the Rhopalocerous Thorax.

After a general consideration of both moth and butterfly thoraces, the former of Thassus, and the latter of Papilio, it is quite easily seen that in fundamental sclerites and processes both parallel each other. The next logical procedure will be to compare the different Rhopalocerous families.

Hesperiidae- Epargyreus tityrus, The Common Skipper. A latero-sternal view of the mesothorax is shown in Fig. 22 and on the whole is seen to be quite moth-like. The epimeron has the characteristic "U" shape with a detached triangular piece dorsal to the meron. Such a feature occurs in the Arctiidae and Saturniidae. The subalare (Sa) is of characteristic shape and meets the projection of the postalar bridge. The basalare (Pba) is quite small in this form.

The episternum (Es) differs somewhat from that of the typical moth. The antecoxale (Acx) is large and only partially marked off from the katepisternum which is also proportionately large. The anepisternum and katepisternum in relation to each other resemble the corresponding parts of the Saturniidae. (See Fig. 12).

The katepisternum, interpleurite and basisternite are only partially marked off from one another by sutures, but the line of demarcation can be discerned as a slight elevation of the chitin in line with the sutures. The unbroken suture dividing the katepisternum from the interpleurite and basisternite of a typical moth thorax (Fig. 17) has now partly disappeared leaving two sutures partially existing between the interpleurite (Ip) and katepisternum (Kes), and basistermite (Bs) and katepisternum (Kes) respectively. In the next higher family, the Papilionidae previously studied (Fig. 10), the suture partly dividing the katepisternum and basisternite in the Hesperiidae is entirely lost, but the one likewise partly marking off the interpleurite from the katepisternum is fully restored. The line of demarcation between the interpleurite and the basisternite in this form (Fig. 22) represented by a very short suture and a chitinous elevation, becomes a well defined suture which coincides with that between the interpleurite and katepisternum (Fig. 20).

The basisternite (Bs) is small being similar to that of the moth. The triangular sclerite anterior to the basisternite and characteristic of all butterflies occurs in this form, but is broader than that of Papilio. The coxa varies very little

from preceding forms. The upper part of the veracoxa (Vcx) is overlapped by the antecoxale region to a considerable extent.

Papilionidae.- Papilio glaucus, Yellow Swallow Tail. This has been previously described under the discussion of a typical thorax of the Rhopalocera. (See Fig. 19).

Pieridae.- Pontia rapae, Cabbage Butterfly.

The thorax of this family (Figs. 23, 24) is extremely similar to that of Papilio. Fig. 24 is a lateral view of the mesothorax showing the well arched mesonotum. The prescutum (Psc, Fig. 9) is small and nearly or quite separate from the scutum and bears a well marked anterior phragma. The tegula proper has been removed. There is a narrow well defined postergite (Pt) which is separated from the postscutellum by a rather wide membranous area. The epimeron is small and extremely narrow at its anterior region. A slight indentation occurs in the lower posterior part. An indication of an antecoxale (Acx) is just distinguishable.

The sternal and episternal plate (Fig. 23) comprising the anepisternum, katepisternum and basisternite is much like that of the Papilionidae in shape and position. The triangular piece above the basisternite is solidly fused with it, whereas in Papilio, a small membranous area exists between it and the basisternite except at the extreme lateral ends where attached. The interpleurite extends along the entire length of the sternal and episternal regions resembling the Papilio in this respect. The basalare (Pba) is a single piece, the small curved plate of the Papilionid basalare having disappeared. The sub-

alare is a long and rather narrow sclerite. The veracoxa is proportionately large and possesses a small but well defined membranous area at its articulation with the trochanter.

Nymphalidae.- Anosia plexippus, Monarch Butterfly.
Argynnis cybele, Great Spangled Fritillary.

Two species of this family have been selected to show the extent of variation of the sclerites in the family. Fig. 5 is a lateral view of the mesothorax of Anosia. The mesonotum is less arched than that of Pontia. Fig. 21 is a dorsal view of the mesonotum which has been described under the discussion of the Papilionidae. The prescutum is shown in Fig. 7 and previously described also under the Papilionidae. The "tegula" proper has been removed.

The epimeron (Em) is solidly chitinized and bears a projection at its lower posterior end, the postcoxal bridge (Poc) which proceeds beneath the coxa and connects with the furcasternite below the sternal median line (Fig. 10). Here a portion of the coxa has been cut off to show the postcoxal bridge in place. This part of the mesopleuron is shown only in (Figs. 10, 25), but in all butterflies, though not so easily seen, it extends from the lower part of the epimeron and proceeds beneath the coxa in like manner.

The antecoxale (Acx) is more prominent than that of the preceding family. The sternal and episternal regions again become distinctly marked by a transverse suture into two plates the anepisternum comprising one and the basisternite and katepisternum the other. This modification presents a marked difference from the single plate which comprises both the sternal and episternal regions of the Papilionidae and Pieridae (Figs. 20, 23).

The interpleurite (Ip) is narrow and somewhat irregular. The sternal projection (Pbs), a portion of which is semi-chitinous is elongate. The basalare and subalare vary but little from those of the Pieridae. The coxa shows no new features.

Fig. 26 is a latere-sternal view of the mesothorax of Argynnis. It is seen in comparing this with Fig. 10 that the two species are much alike. The anepisternum (Fig. 26) is large occupying nearly the whole region directly anterior to the pleural suture (g), consequently the basisternal and katepisternal region is comparatively small. This region also presents a slightly different shape from that of Anosia. The interpleurite (Ip) resembles that of the Pieridae (Fig. 23) in possessing a narrow strip along the upper part of the anepisternum. The basalare and subalare show no distinctive modifications. The wing processes in both species, Anosia and Argynnis are large. It is plainly evident that two species of a family though of different genera show a similarity in fundamental characters as would be supposed.

Summary of the Lepidopterous Thorax.

The Hepialid thorax (Figs. 1, 2, 3) with its large membranous areas in the coxae of all three segments, the large antecoxal region (Acx), the detached or separate trochantins (Tn) in both meso and meta-thoraces, the occurence of the interpleurite (Ip) as a distinct plate and the membranous area between the katepisternum (Kes) and the basisternite (Bs) are primitive features and with slight modifications are found in some of the

lower orders.

The next family in the scale of classification is the Sesiidae (Figs. 11, 12) which show an advance by the complete fusion of the interpleurite (Ip) with the basisternite (Bs) and katepisternum (Kes) and with a complete line of demarcation between the interpleurite and the basisternite but only partial between the interpleurite and the katepisternum. The antecoxale (Acx) has become greatly reduced as characterizes all succeeding families. There are only slight indications of a sternal projection (Pbs) possibly homologous with the prebasiternite of lower insects as previously mentioned, represented by the few chitinous pieces between the interpleurite and basisternite (Fig. 12).

The Geometridae (Fig. 14) are closely allied to the Sesiidae, in fact so close are the fundamentals of each that little need be said. The sternal projection has now become quite prominent and apparently made up from portions of the basisternite and interpleurite. In the three families already mentioned, the Hepialidae, Sesiidae and Geometridae, a narrow membranous strip and a suture occur as the mark of separation between the anepisternum and the katepisternum.

The next two families, the Arctiidae and Lymantriidae (Figs. 15, 16) can be taken together to show several marked differences indicating advancement in structures from the preceding families. The suture partially dividing the katepisternum (Kes) and the interpleurite (Ip, Figs. 15, 16) is now extended to the suture between the anepisternum and the katepisternum and completely divides the katepisternum from the interpleurite.

the suture dividing the anepisternum and the katepisternum does not reach the pleural suture (g) in the Lymantriidae as in the previous families but in the Arctiidae (Fig. 16) the line of demarcation between the anepisternum and katepisternum is again complete, resembling in this feature the three lower families. The suture separating the basisternite from the interpleurite is now eliminated in both families and the line of demarcation between them is merely a slight depression of the chitin.

The sternal projection (Pbs) in the Lymantriidae is small but becomes enlarged to a great extent in the Arctiidae. A large membranous area at the articulation of the coxa and trochanter in the lymantriidae still persists, showing rather a primitive feature. The epimera of both Lymantriidae and Arctiidae are very similar especially in the way of sutures, but differ in the occurrence of a detached triangular plate in the latter. The subalares and the basalares also show an extreme likeness.

The mesothorax (Fig. 17) of the Sphingidae is not materially different from those of the Arctiidae and Lymantriidae. The most marked difference from that of the Arctiidae is in the suture which divides the anepisternum from the katepisternum. It now only partially divides the two divisions of the episternum and is similar in this respect to the Lymantriidae. The line of demarcation as indicated by a slight depression of the chitin between the basisternite (Bs) and interpleurite (Ip) has nearly disappeared.

The Saturniidae (Fig. 18), the highest family in the scale of classification of the Heterocera differs from the

Sphingidae in a few instances. In the lower portion of the epimeral region is a small detached triangular plate similar to that found in the Arctiidae (Fig. 16). The subalare (Sa) is partially semi-chininous as in the Arctiidae and Lymantriidae. The anepisternum is much smaller than that of the Sphingidae and its separation from the katepisternum is also only partial. The line of demarcation between the basisternite and interpleurite is now practically obliterated, the two plates being united into one region.

It is evident that homologies among the Heterocera can be deduced with some difficulty and that to a certain extent phylogenetic relationship can be roughly traced. The families of moths may be roughly divided into four groups as determined by thoracic relationship. The Hepialidae may be put into a class by itself as the most primitive. The Sesiidae and Geometridae may be put into the next group as being somewhat more specialized. The third group may quite easily comprise the Lymantriidae and Arctiidae. Lastly, the fourth group may comprise the Sphingidae and Saturniidae which illustrate the highest type of Heterocerous thorax and of these, the Saturniidae perhaps the highest, as indicated by the fusion of plates and elimination of sutures which apparently tend toward higher specialization.

The Hesperiid thorax (Fig. 22) is without doubt the most primitive of the butterfly group. Its general shape and that of its component parts closely resembles the typical moth thorax. The particular butterfly feature may be cited as the triangular sternal projection (Pbs). It is also evident

that there is a further tendency for the elimination of sutures clearly manifest in the next two families.

Gradual modifications of form and structure as roughly perceived in all previous families of the Lepidoptera do not continue with like precision in going from the Hesperiidae to the Papilionidae and Pieridae (Figs. 19,20,23,24). A sudden change of form and structure occurs whereby the last two mentioned families represent the highest type of butterfly thorax as well as the highest of the Lepidopterous group. The basis for this opinion rests on the absence of sutures and divisions especially in the sternal and episternal regions. The Papilionidae and Pieridae can easily be grouped together having much in common. There is undoubtedly a close relationship between the two.

The Nymphalidae (Figs. 1,25,26,) the highest family listed in the Lepidoptera, does not represent such according to thoracic characters. The presence of the transverse suture across the lower episternal region places it beneath the Pieridae and Papilionidae. The great Spangled Fritillary (Fig. 26) shows a slightly higher modification than the Monarch in that the <u>interpleurite</u> (Ip) is of the Pierid type (Fig. 23).

<u>Conclusions</u>.

Taking the Lepidopterous group as a whole the butterflies are more highly specialized than the moths as can be observed by thoracic characters. To take each family and indicate where it shows distinct features

pointing to higher specialization from the preceding one is exceedingly difficult, yet by grouping the various families showing similarities, one group is seen to be higher than the other.

In the lower forms the differences are most pronounced,but as the higher forms are studied, the differences as a whole become less marked and accordingly interpretation more difficult. Variations of course have to be taken into consideration and as is admitted by all morphologists and systematists, no one part of the anatomy can solely determine the place of an insect in the phylogenetic scale of classification.

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Abbreviations.

Aes. Anepisternum

Abd. Abdomen

Fs. Furcasternite

g. Pleural suture (between episternum and epimeron).

Axc. Axillary cord.

Acx. Antecoxale.

Anp. Anterior notal wing process.

Aphg. Anterior phragma.

Apt. Adanal pterale.

Bs. Basisternite.

Cs. Cervical sclerite.

Cx. Coxa.

Em. Epimeron.

Es. Episternum.

Pat. Patagia.

Pba. Posterior basalare.

Pbs. Prebasisternite (Sternal projection).

Pcx. Precoxale (precoxal bridge).

Pnp. Posterior notal wing process.

Poa. Postalar bridge.

Poc. Postcoxale (post-coxal bridge).

Psc. Prescutum

~~episternum and epimeron)~~

Ip. Interpleurite.

Kes. Katepisternum.

l. Meral suture (between meron and anterior portion of coxa).

m. Medipterale.

Me. Meron.

Mpt. Metopterale.

Psl. Postscutellum.

Pt. Postergite.

Sa. Subalare.

San. Basanal pterale.

Sc. Scutum.

Scsl. Scuto-scutellum.

Sl. Scutellum.

Sp. Spiracle.

Tg. Tegula.

Tn. Trochantin.

Vcx. Veracoxa

Wp. Wing process.

Explanation of Plates.

1.

Fig. 1. Lateral view of prothorax of Phassus.

Fig. 2. Lateral view of mesothorax of Phassus.

Fig. 3. Lateral view of metathorax of Phassus.

Fig. 4. Dorsal View of mesothorax of Sphinx.

Fig. 5. Dorsal view of prothorax of Samia.

Fig. 6. Frontal view of mesothoracic prescutum of Sphinx.

Fig. 7. Frontal view of mesothoracic prescutum of Anosia.

Fig. 8. Frontal view of mesothoracic prescutum of Phassus.

Fig. 9. Frontal view of mesothoracic prescutum of Pontia.

Fig. 10. Latero-sternal view of mesothorax of Anosia.

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Fig. 11. Lateral view of mesothorax of Bembecia.

Fig. 12. Latero-sternal view of mesothorax of Bembecia.

Fig. 13. Latero-sternal view of mesothorax of Arctia.

Fig. 14. Latero-sternal view of meosthorax of Metrocampa.

Fig. 15. Lateral view of mesothorax of Porthetria.

Fig. 16. Lateral view of mesothorax of Arctia.

Fig. 17. Lateral view of mesothorax of Sphinx.

Fig. 18. Lateral view of mesothorax of Samia.

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Fig. 19. Lateral view of thorax of Papilio; 1, prothorax; 2, mesothorax; 3, metathorax.

Fig. 20. Latero-sternal view of mesothorax of Papilio.

Fig. 21. Dorsal view of mesothorax of Anosia.

Fig. 22. Latero-sternal view of mesothorax of Epargyreus.

Fig. 23. Latero-sternal view of mesothorax of Pontia.

Fig. 24. Lateral view of mesothorax of Pontia.

Fig. 25. Lateral view of mesothorax of Anosia.

Fig. 26. Latero-sternal view of mesothorax of Argynnis.